

**VOLUME II**

**5X800 MW YADADRI TPS #UNIT 1,2,3,4,5**

**TELANGANA STATE POWER GENERATION  
CORPORATION LTD**

**TECHNICAL SPECIFICATION**

**FOR**

***NEUTRAL GROUNDING RESISTOR***

**SPECIFICATION NO: *PE-TS-417-506-E001***

***REVISION: 0***



**BHARAT HEAVY ELECTRICALS LIMITED**

**POWER SECTOR**

**PROJECT ENGINEERING MANAGEMENT**

**NOIDA, UP (INDIA) – 201301**



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

CONTENT SHEET

REVISION 0

DATE: 19.06.2021

SHEET 1 of 1

**CONTENTS**

| <b><u>S. NO.</u></b>                       | <b><u>DESCRIPTION</u></b>                          | <b><u>NO. OF SHEETS</u></b> |
|--------------------------------------------|----------------------------------------------------|-----------------------------|
| 1.                                         | COVER SHEET                                        | 01                          |
| 2.                                         | CONTENTS                                           | 01                          |
| 3.                                         | COMPLIANCE CERTIFICATE                             | 01                          |
| 4.                                         | SECTION – I (TITLE)                                | 01                          |
|                                            | a) SPECIFIC TECHNICAL REQUIREMENTS                 | 14                          |
|                                            | b) DATA SHEET-A                                    | 03                          |
|                                            | c) DATA SHEET-C (GUARANTEED TECHNICAL PARTICULARS) | 03                          |
| 5.                                         | SECTION – II (TITLE)                               | 01                          |
|                                            | a) GENERAL TECHNICAL SPECIFICATION                 | 05                          |
|                                            | b) QUALITY PLAN                                    | 06                          |
| <b>TOTAL NO. OF SHEETS=</b>                |                                                    | <b>36</b>                   |
| <b>(INCLUDING COVER/ SEPARATOR SHEETS)</b> |                                                    |                             |



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

COMPLIANCE CERTIFICATE

REVISION 0

DATE: 19.06.2021

SHEET 1 of 1

**COMPLIANCE CERTIFICATE**

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same
2. There are no deviation with respect to specification other than those furnished in the 'schedule of deviations'
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ-Cum-Price schedule' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

-----  
BIDDER'S STAMP & SIGNATURE



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

**SECTION –I**

**SPECIFIC TECHNICAL REQUIREMENTS**



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 1 OF 10

**1.0 SCOPE OF ENQUIRY**

- 1.1 Design, Manufacture, Inspection and Testing at Manufacturer's works, proper packing and delivery to site of NEUTRAL GROUNDING RESISTOR conforming to this specification.
- 1.2 General technical requirements of the NEUTRAL GROUNDING RESISTOR are indicated in Section-II. Project specific technical/ quality requirements / changes are listed in Section-I.
- 1.3 The stipulations of Section-I, followed by those of Data Sheet-A shall prevail in case of any conflict between the stipulations of Section-I, Data Sheet - A & Section-II.
- 1.4 The documents shall be in English Language and MKS system of units.

**2.0 BILL OF QUANTITIES:**

- 2.1 Quantity requirements shall be as per 'BOQ-cum-price schedule' as part of NIT.

**3.0 SPECIFIC TECHNICAL REQUIREMENTS**

| <b>S.No.</b> | <b>Reference Clause No. of Section- II</b> | <b>Specific Requirement/ Change</b>                                                                                                                                                                                                                                                                                                  |
|--------------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.           | 5.1.1                                      | Shall be read as: " Each Neutral Grounding Resistor shall be formed of nonaging (grade ASTM-A240/AISI-304 or better) corrosion resistant punched stainless steel elements for 300A of earth fault current. Resistance material mentioned above shall have high electrical resistivity and low temperature coefficient of resistance. |
| 2.           | 5.1.2                                      | Shall be read as : "Resistor bank shall be provided in series and parallel combination as mentioned in datasheet A to achieve the overall resistance value. Adjacent banks shall be insulated from each other and the metal frame."                                                                                                  |
| 3.           | 5.1.3                                      | Shall be read as : "The resistor unit shall consist of suitable no. of elements. All the elements shall be mounted inside the cubicle so as to ensure ease of inspection and replacement of individual element.                                                                                                                      |
| 4.           | 5.1.10                                     | Shall be read as follows:<br>"All the 11 kV & 3.3 kV NGR shall be connected to respective transformer neutral by Cable ( 11 kV NGR by 11/11kV(UE) 1C-240 sq mm Al cond., XLPE insulated armoured cable and 3.3 kV NGR by 3.3/3.3 kV (UE) 1C-240 sq mm Al cond., XLPE insulated armoured cable).                                      |



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 2 OF 10

|    |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5. | 5.1.11 | Cl. No. 5.1.11 shall be added as follows: "The resistor element shall be insulated from supporting bars by mica tubes. Supporting bar shall be insulated by porcelain insulators."                                                                                                                                                                                                                                                                                                                                                                                           |
| 6. | 5.2.5  | Clause 5.2.5 shall be read as "The enclosure shall be supported on insulators placed on mounting structure (provided with suitable base channels for direct bolting to the foundation at site) in such a fashion that it is not easily accessible for man standing on ground level. Base of NGR enclosure should be at a height of 2.5m above ground level".                                                                                                                                                                                                                 |
| 7. | 5.2.11 | Clause 5.2.11 shall be read as follows : "For connection of other end of NGR to ground, Tinned copper flat (of size 50mm x 6mm) with Fork connector up to 300mm above ground with 2 nos. earthing terminal/pad, tapped holes and bolts suitable for Connection of 75X10 mm GS flats shall be provided by Bidder. The tinned copper flat shall be insulated from mounting structure through porcelain Insulators. GS flat for connection of fork connector of NGR to ground is excluded from bidder's scope." The length of copper flat shall be suitably decided by bidder." |
| 8. | 6.1    | In addition to existing clause, following shall also be applicable:<br>"Each equipment shall be completely assembled, wired, and routine tested as per relevant standards at manufacturer's works. The routine tests shall include:<br>(i) Resistance measurement<br>(ii) Voltage measurement<br>(iii) Insulation resistance measurement<br>(iv) Dielectric test"                                                                                                                                                                                                            |
| 9. | 6.2    | 1.Clause 6.2 shall be read as "Bidder shall furnish Type Test certificates for DOP tests conducted on similar type of equipment for purchaser's review at contract stage. the report shall not be earlier than five (5) years prior to the zero date of the project i.e <b>17.10.2017</b> & conduct the Temperature rise test on one unit of each rating.                                                                                                                                                                                                                    |



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 3 OF 10

|     |                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10. | 6.3 & Remarks for "TYPE TESTs" mentioned in "STANDARD QUALITY PLAN" (QP NO.: PE-QP-999-506-E001, REV. 02) | <p>1.Clause 6.3 &amp; Remarks for "TYPE TESTs" mentioned in "STANDARD QUALITY PLAN" (QP NO.: PE-QP-999-506-E001, REV. 02) shall be read as follows:</p> <p>For all components / materials, for which type test reports have been asked for in the specification, such Type tests should have been carried out on identical components / materials. The type test should have been conducted within 5 yrs from the date 17.10.2017.</p> <p>In absence of such valid type tests reports or in case such reports are not found to be meeting the specification/standards requirements, vendor shall conduct all such type tests i.e DOP test on enclosure and terminal box except temperature rise test without any commercial/delivery implication to BHEL according to the relevant standards and reports shall be submitted to the owner for approval. Bidder has to do temperature rise test on one unit of each rating which has been mention BOQ-CUM-UNPRICED SCHEDULE and its reports shall be submitted to the owner for approval.</p> |
| 11. | 6.5                                                                                                       | BHEL Quality Plan no. PE-QP-999-505-E001 read as BHEL "STANDARD QUALITY PLAN (QP NO.: PE-QP-999-506-E001, REV. 02)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 12. | 7.2                                                                                                       | <p>Shall be replaced with following :</p> <p>"All surface shall be sand blasted, pickled and grounded as required to produce a smooth, clean surface free of scale, grease &amp; rust."</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 13. | 7.5                                                                                                       | <p>Shall be read as follows:</p> <p>"After cleaning, the surfaces shall be given a phosphate coating followed by 2 coats of high quality primer and stoved after each coat. The cubicle shall be finished in Light Grey # 631 of IS 5 with two coats of synthetic enamel paint.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 14. | 7.6                                                                                                       | <p>Shall be read as follows:-</p> <p>The minimum thickness of paint shall be 100 Microns.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 15. | 7.9                                                                                                       | <p>Shall be added as follows:</p> <p>"Sufficient quantity of touch-up paint ( approx. 1 litre) shall be furnished for each NGR for future application at site."</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 4 OF 10

**3.1 CODES AND STANDARDS**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

**3.2 DESIGN CRITERIA**

The Neutral Grounding Resistor (NGR) shall be used for non-effective grounding of 11000 Volt and 3300 Volt System of the plant. NGR shall be connected between transformer 11000 and 3300 Volt side winding neutral points and earth.

Neutral Grounding Resistor shall be used to limit the magnitude of earth fault current so that damage of electrical equipment is reduced, safety of personnel is increased and sensitive, selective earth fault protection can be provided.

The NGR will be installed in dust prone, hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

The Resistor unit shall be air-cooled type suitable for installation at outdoor locations and shall meet arduous, heavy duty industrial application, shall be unbreakable, rigid, resilient & rustless. The thermal loading of the resistance box should be uniform.

The resistor enclosure shall be made of sheet steel and shall have minimum thickness of 2 mm.

**3.3 SPECIFIC REQUIREMENTS****3.3.1 Resistor**

The resistor element shall be made of non-aging stainless steel having high electrical resistivity and low temperature co-efficient of resistance. Group of resistor elements shall be mounted together between end plates to form a bank. Banks are then to be connected in series-parallel combination to provide the current and ohmic value required. Adjacent banks shall be insulated from each other and the metal frame.

The resistor unit shall consist of a no. of elements. All the elements shall be mounted inside the cubicle so as to ensure ease of inspection and replacement of individual element.

Each Resistor element shall possess a balanced combination of both Mechanical and Electrical properties over the entire intended operating temperature range without any harmful effect on the elements and their accessories.



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 5 OF 10

All the resistor elements constituting the NGR shall be assembled and supported inside the cubicle in such a way that no distortion or breakage will occur during the passage of through fault current to earth.

All element connections shall be bolted type to ensure stable resistance value throughout the working life of the unit.

Wet process type brown glaze porcelain insulators shall be used for supporting resistor elements. Porcelain insulators shall have high creepage value suitable for heavily polluted atmosphere charged with dust particles.

The tie rod shall be insulated from the supporting structure by suitable insulators.

All Resistance Bank to Bank interconnections shall be done by solid stainless steel / copper.

### **3.3.2 Enclosure**

Each neutral grounding resistor shall have structural steel work enclosed on all sides and also on top by sheet steel having a minimum thickness of 2 mm. Suitable ventilating louvers shall be provided on sides to ensure proper ventilation. The louvers shall be provided with fire wire mesh to make it vermin proof. Protection class shall be IP33 or better.

Each enclosure shall be self supporting, weather proof type suitable for outdoor mounting. A sloped bottom sheet is welded to the angle iron structure and drain plug shall be provided at suitable place.

Each cubicle shall be complete with a front access door with handles, lock and also a removable bolted cover. All doors and removable covers shall be properly gasketed with neoprene rubber gaskets. All cubicle door hinges shall be concealed type.

Each cubicle shall be provided with suitable base channels for direct bolting to the foundation at site. All necessary galvanised bolts, nuts, washers etc. shall be supplied by the bidder for installation of Cubicle at site.

### **3.3.3 Cubicle lamp , sockets and Panel space heater arrangement.**

Each cubicle shall be provided with 5A, 5 pin plug socket and door-switch controlled cubicle illumination lamp.

Two pole switch fuse unit shall be provided for receiving 240 V single phase AC supply for cubicle lamp and illumination circuit.

Panel space heater arrangement along with thermostat, suitable for connection to 240V AC single supply, shall be provided at the bottom of the panel.

### **3.3.4 Wiring**

All internal wiring between equipment and terminal block shall be carried out by fire resistance PVC insulated 1100V grade 2.5 Sq.mm Stranded copper conductor wires.

All wiring shall be suitably ferruled with corresponding wiring identification marks used in the Schematic/wiring diagrams.



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 6 OF 10

All devices and terminal blocks within the terminal box shall be clearly identified by symbol corresponding to those used on applicable schematic/wiring diagram. 20% spare terminals shall be provided in terminal block.

The connection between Neutral terminal of transformer and NGR shall be through cable supplied by BHEL. A Cable box complete with required hardware (Double compression brass Cable glands and cable lugs) suitable for the cable size selected by BHEL shall be provided on NGR cubicle for terminating the cable. The cable box shall be dust tight, air insulated type with DOP of IP:55, as per IS 13947. Cable entry shall be through bottom.

**3.3.5 Grounding**

Each cubicle shall be completed with two (2) nos. ground pads, tapped holes and bolts suitable for connection of 75 x 10 mm galvanised steel flats.

**3.3.6 Painting**

Painting requirements has been mentioned above clauses of this section (i.e section-I). Final details of painting shall be decided during detailed engineering.

**3.4 Packaging:-**

Packing shall be as per Attachment IV to Section I.

**3.5 Standard Quality Plan**

**1.Standard Quality Plan** (QP NO.: PE-QP-999-506-E001, REV. 02) is attached with this specification. This may change during detailed engineering and there shall be no commercial or delivery implication to BHEL on account of QP change and its approval during detailed engineering.

**4.0 DOCUMENTATION**

4.1 Documents required along with technical offer shall be as per attachment-I.

4.2 Documents required after award of LOI shall be as per attachment-II.

4.3 No. of prints to be submitted by vendor after award of contract shall be as under:-  
as per attachment-III.

4.3 Documents/drawings shall be submitted through DMS.

4.4 During contract vendor to submit drawing/document submission schedule.

4.5 Packing details as per attachment IV.



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 7 OF 10

**ATTACHMENT – I**

**DOCUMENTS REQUIRED ALONG WITH TECHNICAL OFFER.**

Sign & stamped copy of following documents:

- a] "Deviation Schedule" with "NO Deviations" and bidder's signature and company stamp.
- b] Unpriced Price Schedule as enclosed with NIT with 'Quoted' word against items with bidder's signature and company stamp.
- c] A copy of the sheet "Compliance Certificate" with bidder's signature and company stamp.
- d] A copy of the sheet "Content Sheet" with bidder's signature and company stamp.

|                                                                                   |                                                                                         |                                       |                  |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------------|------------------|
|  | DOCUMENT TITLE<br><br><b>TECHNICAL SPECIFICATION FOR<br/>NEUTRAL GROUNDING RESISTOR</b> | SPECIFICATION NO. PE-TS- 417-506-E001 |                  |
|                                                                                   |                                                                                         | VOLUME II                             |                  |
|                                                                                   |                                                                                         | SECTION I                             |                  |
|                                                                                   |                                                                                         | REVISION - 0                          | DATE: 19.06.2021 |
|                                                                                   |                                                                                         | SHEET 8 OF 10                         |                  |

## **ATTACHMENT – II**

### **DOCUMENTS REQUIRED AFTER AWARD OF LOI.**

In addition to documents specified in NIT, following documents/drawings shall be submitted after placement of order for BHEL's approval: -

| Sl. No. | Drawings/Document Description  | Drawings / Document Number | Primary / Secondary |
|---------|--------------------------------|----------------------------|---------------------|
| 6.      | BILL OF MATERIAL (BOM) FOR NGR | PE-V0-417-506-E017         | Secondary           |

#### **NOTE-**

1. In BOM each of the item to be uniquely identified with item code no. or item Sl. no. Supplier to ensure that all the items which will find separate mention in the packing list are covered in detailed BOM. Supplier to give following undertaking in BOM: " The BOM provided here completes the scope ( in content and intent) of material supply under PO no. ---- dtd ----- Any additional material which may become necessary for the intended application of supplied item/package will be supplied free of cost in most reasonable time."



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 9 OF 10

**ATTACHMENT – III**

No. of prints to be submitted by vendor after award of contract shall be as under:-

| S.NO. | DESCRIPTION                                                                              | No. hard /soft<br>copies     | No. of CDROMs | REMARKS |
|-------|------------------------------------------------------------------------------------------|------------------------------|---------------|---------|
| 1.    | Docs. /drgs. for<br>approval<br>(First submission)                                       | PDF File + 4<br>Hard copies  | NIL           |         |
| 2.    | Drgs. / docs. for<br>approval<br>(Second &<br>subsequent<br>submission till<br>approval) | PDF File + 4<br>Hard copies  | NIL           |         |
| 3.    | Final approval<br>drgs. /<br>docs. for<br>Distribution after<br>CAT-1.                   | PDF File + 10<br>Hard Copies | 4 CD-ROM      |         |
| 4.    | As Built<br>drgs./doc.                                                                   | PDF File + 10<br>Hard Copies | 6 CD-ROMS     |         |
| 5.    | Operation,<br>Erection &<br>Maintenance<br>manual for<br>approval                        | PDF File + 2<br>Hard Copies  | NIL           |         |
| 6.    | Approved<br>Operation &<br>Maintenance<br>Manual for<br>distribution                     | PDF File + 10<br>Hard Copies | 6 CD-ROMS     |         |
| 7.    | Type Test<br>Certificates/<br>Reports for<br>approval                                    | PDF+ 2 hard<br>Copies        | NIL           |         |
| 8.    | Type Test<br>Certificates/<br>Reports for<br>distribution                                | 10 hard Copies               | 6 CD-ROMS     |         |



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 10 OF 10

## **ATTACHMENT – IV to SECTION I**

## Packing:

- A. Support Structure of NGR shall be despatched in open in such a manner there shall be no damage during transit.
- B. NGR shall be despatched in “Crate Packing” using wood

### 1.0 PREPARATION OF PACKING CASES:

#### 1.1 DIMENSIONS:

- 1.1.1 Minimum number of planks shall be used for a shook.
- 1.1.2 Thickness of planks for Front, rear, top and bottom sides and binding, jointing battens shall be 25/20mm +2/-3 mm
- 1.1.3 Horizontal, vertical, diagonal planks shall be given for binding
- 1.1.4 Width of binding planks shall be minimum 100mm
- 1.1.5 Distance between any 2 binding planks shall be less than 750mm
- 1.1.6 Diagonal planks shall be used in between vertical binding planks when distance between inner to inner of vertical planks is more than 750mm
- 1.1.7 Distance of the outer edges of these planks from the edge of case shall be less than 250mm.
- 1.1.8 Diagonal planks are not required for top planks and width side, if the width of pallet is less than 750mm.

#### 1.2 JOINTING OF PLANKS:

Single length planks shall be used for cubicles whose overall length is less than 2400mm. For cubicles of length more than 2400mm, jointing is permitted. The jointing shall be done with one single or maximum of 2 planks of wood same as other planks of width 250 mm (minimum) with two rows of nails on either side of the joint in zigzag

manner. From the joint along height side, it shall be of lap joint with overlap of at least the width of plank.

### 1.3 TONGUE AND GROOVE JOINTS

Two consecutive planks shall be joined by tongue and groove joint. Depth of tongue shall be 12+1 mm, thickness of tongue shall be 8 +1 mm. The groove dimensions shall be such that the tongue fits tightly into the groove to make a good joint. This type of joint can be done based on the product requirement wherever required.

### 1.4 PERMISSIBLE DEFECTS

Wood shall be free from knots, bows, visible sign of infection and any kind of decay caused by insects, fungus, etc.

**End splits:** Longest end splits at each end shall be measured and lengths added together. The added length shall not exceed 60mm per meter run of shook's. Wood pins shall be used to prevent further development of split.

**Surface cracks:** Surface cracks with a maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

### 1.5 OTHER MATERIALS

#### 1.5.1 NAILS

The dia. of the nails shall be 3.15mm. The length of the nails shall be 65mm wherever two planks of 25mm thickness are joined and 75mm wherever a 25mm planks is joined to a 50mm plank.

#### 1.5.2 BLUE NAILS

These are used for nailing bituminized Kraft paper/hessian cloth to the planks. The length of the nails shall be 16mm.

### 1.5.3 HOOP IRON STRIPS

These are used for strapping the boxes. The width of the strips shall be  $19 \pm 1$ mm and thickness  $0.6 \pm 0.01$ mm. The material shall be free from rust. If sufficient nailing is done for bigger boxes, strapping need not be done.

### 1.5.4 CLIPS

These shall be used for strapping the hoop iron strips on the boxes.

### 1.5.5 BRACKETS

These brackets are used for nailing to the corners of cubicle boxes. The brackets shall be of mild steel of thickness min 2mm and width  $25 \pm 1$ mm. The brackets shall be of "L" shape, the length of each side being  $100 \pm 2$ mm. Two holes shall be provided towards the end of each side for screwing /nailing.

### 1.5.6 MULTI LAYERED CROSS LAMINATED POLYTHELENE FILM

100GSM (Colourless) Multi Layered Cross Laminated Polyethylene Film Specification No: AA51420 are used to make covers to the jobs individually. The cross lamination gives qualities of extra toughness, together with flexibility and lightness coupled with good weather resistance to ultra violet rays.

### 1.5.6 RUBBERISED COIR:

The rubberized coir is used as cushioning material. For the packing of loose items, items are to be arrested by using rubberized coir. For the packing of cubicles rubberized coir of thickness 25mm and width 75mm shall be used.

### 1.5.7 FASTENERS

Bolts, double nuts, spring washers will have to be used to hold the job to the bottom plank of the box so that there shall be no jerk on the NGR during transit.

### 1.5.8 PACKING SLIP:

Packing slip kept in the polyethylene bag shall be placed in the box at appropriate place. In addition, one more packing slip covered in polyethylene cover and packing slip holder shall be nailed to front / rear of case.

### 1.5.9 MARKING PLATE:

Marking on the packing case shall be done as per the manufacturer standard.



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 1 OF 3

**DATA SHEET-A****1.0 SYSTEM DESIGN DATA**

- 1.1 Design Ambient : ☒ 50°C ☐ 40°C
- 1.2 Reference Standard : IEEE – 32
- 1.3 Rated Voltage : As specified in BOQ-Cum-Price Schedule in NIT
- 1.4 voltage & frequency variation : voltage: +-10%, frequency: +3to -5%
- 1.5 Location of NGR : Outdoor
- 1.6 Rated short time current and time : As specified in BOQ-Cum-Price Schedule in NIT
- 1.7 a) Net resistance of resistor unit : As specified in BOQ-Cum-Price Schedule in NIT
- b) Tolerance in resistance : +-10%
- 1.8 Resistance per resistor element : As per Requirement
- 1.9 Material of resistor element
- Non-aging Punched stainless steel
- i) For high value of current : ☒ AISI-304 ☒ ASTM-A240 ☐ AISI-A406  
(Say 300/400/500A)
- ii) For low value of current (say 1A) : ☐ AISI-406
- 1.10 No. of parallel Path : ☐ Two, ☒ Six (6X6), (Series-parallel)
- 1.11 No. of resistance element par path : As per Requirement
- 1.12 Total no. resistor elements : As per Requirement
- 1.13 Current density of resistor element : As per Requirement
- 1.14 Max. allowable temp. rise (over ambient)  
of resistor element : ☐ 300° C ☒ 350° C  
☐ 500° C ☐ 790° C
- 1.15 Max. allowable temp. rise (over ambient)  
of enclosure : ☐ 20° C ☒ 30° C



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 2 OF 3

**2.0 ENCLOSURE**

- 2.1 Material and thickness : Sheet Steel and [☒] 2.0 [☐] 2.5 [☐] 3.0 mm
- 2.2 Degree of Protection (As per IS13947)
- i) Enclosure : [☒] IP-33 + additional canopy [☐] IP-55 with canopy
- ii) Terminal Box : IP-55 + additional canopy

**3.0 SUPPORT INSULATORS**

- 3.1 Material : Porcelain
- 3.2 Insulation class of insulating material Over 220°C : Class R (IEC class 200) :
- 3.3 Rated voltage
- i) For 11kV NGR : 12 kV
- ii) For 3.3kV NGR : 3.6 kV
- iii) For LV NGR : 1.1kV
- 3.4 One minute power frequency dry withstand voltage
- i) For 11kV NGR : 75/28kV (peak/rms)
- ii) For 3.3kV NGR : 40/10kV (peak/rms)
- 3.5 Creepage Distance : [☐] 25mm/KV [☒] 31 mm/KV

**4.0 PAINT/FINISH**

- 4.1 Enclosure : As Specified in Sec-I
- 4.2 Paint Finish
- a) Interior : As Specified in Sec-I
- b) Exterior : As Specified in Sec-I
- 4.3 Paint thickness
- (i) Spray Painting : As Specified in Sec-I
- (ii) Powder coating : As Specified in Sec-I



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION I

REVISION - 0

DATE: 19.06.2021

SHEET 3 OF 3

**5.0 MOUNTING STRUCTURE (BOLTABLE TYPE)**

- 5.1 Material : Hot dip galvanised standard steel section
- 5.2 Thickness/deposit of galvanisation : 75 microns/610 g/m<sup>2</sup>
- 5.3 Equipment mounting : Base of NGR enclosure at 2.5m above ground

**6.0 TERMINAL CONNECTION**

- 6.1 Type : Bushing
- 6.2 Material : Porcelain
- 6.3 Rated voltage
- i) For 11kV NGR : 12kV
- ii) For 3.3kV NGR : 3.6kV
- 6.4 One minute power frequency dry withstand voltage
- iii) For 11kV NGR : 75/28kV (peak/rms)
- iv) For 3.3kV NGR : 40/10kV (peak/rms)
- 6.5 Creepage Distance : [ ] 25mm/KV [√] 31 mm/KV
- 6.6 Connection between NGR & transformer Neutral : [√] Cable [ ] GI Flat [ ] Tinned Copper Flat

Cable size: 1CX240 sqmm XLPE insulated Armoured cable for 11kV NGR & 3.3kV NGR

**7.0 INSULATION CLASS OF INSULATING MATERIAL : Over 220°C Class R (IEC class 200)**



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION-I

REVISION 0

DATE: 19.06.2021

SHEET

**DATA SHEET-C  
(To be filled up by bidder)****1.0 General**

- 1.1 Make/Type :
- 1.2 Quantity Nos. :
- 1.3 Service :
- 1.4 Reference Standard :

**2.0 Resistor**

- 2.1 Rated Voltage (Volt) :
- 2.2 Net Resistance at 50 Deg. C (ohm) :
- 2.3 Resistance per resistor element at 50 Deg. C :
- 2.4 Tolerance limit on resistance at 50 Deg. C (%) :
- 2.5 Total no. of resistor elements per path :
- 2.6 No. of parallel path :
- 2.7 Material of resistor element :
- 2.8 Electrical Resistivity (Ohm-cm) :
- 2.9 Temperature Co-efficient of resistance/ Deg C :
- 2.10 Current rating
- a) Short time rating Amps., Secs :
- 2.11 Types of grid :
- 2.12 Temperature rise (over Ambient 50 Deg. C) :
- 2.13 Method of connecting elements :

**3.0 Insulation level**

- 3.1 One minute power frequency withstand volt. KVrms :



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION-I

REVISION 0

DATE: 19.06.2021

SHEET

**4.0 Support insulator**

- 4.1 Make :
- 4.2 Material :
- 4.3 Creepage distance :
- 4.4 Voltage rating :
- 4.5 One minute power frequency withstand volt.(dry) KVrms :

**5.0 Terminal connection**

- 5.1 Type :
- 5.2 Make :
- 5.3 Material :
- 5.4 Voltage rating :
- 5.5 Power frequency withstand volt. KVrms :

**6.0 Enclosure Cubicle**

- 6.1 Enclosure material :
- 6.2 Thickness of enclosure materials :
- 6.3 Degree of protection :
- 6.4 Reference standard :
- 6.5 Painting shade :
- 6.6 Thickness of paint (mm) :
- 6.7 Dimension of NGR cubicle with resistor :
- 6.8 Weight of complete NGR cubicle  
with resistors ( W/O Mounting structure) :

**7.0 Test Voltage**

- 7.1 One minute power frequency withstand volt.(dry) KVrms :
- 7.2 Impulse withstand voltage (peak) KV :

**8.0 Mounting Structure**

- 8.1 Materials :



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION-I

REVISION 0

DATE: 19.06.2021

SHEET

- |      |                                           |   |
|------|-------------------------------------------|---|
| 8.2  | Dimensions                                | : |
| 8.3  | Paints/Galvanisation                      | : |
| 8.4  | Wt. Of mounting structure                 | : |
| 9.0  | Whether space heater arrangement provided | : |
| 10.0 | Whether welded or bolted type             | : |



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR  
NEUTRAL GROUNDING RESISTOR**

SPECIFICATION NO. PE-TS- 417-506-E001

VOLUME II

SECTION II

REVISION 0

DATE: 19.06.2021

**SECTION – II**

**GENERAL TECHNICAL SPECIFICATION**



## TECHNICAL SPECIFICATION FOR NEUTRAL GROUNDING RESISTOR

SPECIFICATION NO. PE-SS- 999-506-E001

VOLUME II

SECTION - II

REVISION 01

DATE: 19.02.2019

SHEET 1 OF 5

### 1.0 SCOPE OF ENQUIRY

- 1.1** This specification covers the design, manufacture, assembly, testing and inspection at vendor's/sub-vendor's works, packing and despatch to site of neutral grounding resistor as described in the various sections of this specification.
- 1.2** Although erection and commissioning is not included in vendor's scope, the vendor shall still not be absolved of his responsibility of establishing the correctness of equipment at site.

### 2.0 CODES & STANDARDS

- 2.1** The material, constructional features and various processes involved in manufacture shall comply with latest revision of Indian Standards.
- 2.2** The design, material, construction, manufacture, inspection, testing and performance of Neutral Grounding Resistor shall conform to the latest revision of relevant standards and codes of practices mentioned in Datasheet – A.
- 2.3** In case of conflict between the applicable reference standard and this specification, this specification shall govern.

### 3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

- 3.1** The NGR is used for medium resistance grounding of MV (11 / 6.6 / 3.3KV) or LV (415 V) system. NGR shall be connected between earth pit and neutral point of applicable transformer.
- 3.2** The NGR shall be suitable for limiting the desired value of earth fault current and duty as specified in BOQ-Cum-Price Schedule in NIT.
- 3.3** The resistor unit shall be natural air-cooled type suitable for installation at outdoor/ indoor locations.
- 3.4** The NGR will be installed in hot humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

### 4.0 TERMINAL POINTS OF SUPPLY:

- a) Neutral grounding resistor along with suitable cable glands and lugs for incoming cables from transformer neutral.
- b) Supporting structure along with insulators and necessary foundation hardware.
- c) Bushing along with tinned copper strip of suitable cross-section (as specified in Datasheet-A / BOQ-cum-Price Schedule in NIT) and connecting hardware for neutral connection of transformer. Copper strip will be applicable only when cable connection is not applicable and vice-versa.
- d) All Civil works, Erection & commissioning of equipment are excluded from bidder's scope.
- e) Termination and Jointing kits are excluded from bidder's cope.

### 5.0. SPECIFIC TECHNICAL REQUIREMENTS

#### 5.1 NEUTRAL GROUNDING RESISTOR



## TECHNICAL SPECIFICATION FOR NEUTRAL GROUNDING RESISTOR

SPECIFICATION NO. PE-SS- 999-506-E001

VOLUME II

SECTION - II

REVISION 01

DATE: 19.02.2019

SHEET 2 OF 5

- 5.1.1 Each Neutral Grounding Resistor shall be formed of non-aging (grade ASTM-A240/AISI-304 or better) corrosion resistant punched stainless steel elements or FECRAL (AISI-406) as specified in data sheet-A for high value (say 300A/400/500A) of earth fault current and of FECRAL (AISI-406) material for low value (say 1A) of earth fault current. Resistance material mentioned above shall have high electrical resistivity and low temperature co-efficient of resistance.
- 5.1.2 Resistor bank shall be provided in series and parallel combination to achieve the overall resistance value. Minimum two banks in parallel shall be provided in the system, unless specified otherwise.
- 5.1.3 The resistor unit shall consist of suitable no. of elements. All the elements shall be mounted inside the cubicle so as to ensure ease of inspection and replacement of individual element. For Low value of earth fault current edge wound configuration of resistance material is also acceptable.
- 5.1.4 Each resistor element shall possess a balanced combination of both Mechanical and Electrical properties over entire intended operating temperature range without any harmful effect on the elements and their accessories.
- 5.1.5 All the resistor elements consisting the NGR shall be assembled and supported inside the cubicle in such a way that no distortion or breakage will occur during the passage of specified fault current to earth.
- 5.1.6 All elements connection shall be bolted type to ensure stable resistance value throughout the working life of the unit.
- 5.1.7 Wet process type brown glass porcelain insulators shall be used between Tie-rod and end support structure and shall also be used to insulate the resistor bank from enclosure. Porcelain insulators shall have high creepage value (as specified in Data sheet-A) suitable for heavily polluted atmosphere charged with dust particles. Interposing insulator (except Mica) shall be provided to insulate resistor tier.
- 5.1.8 The resistor elements shall be provided with necessary installations and shall have maximum temperature rise as specified in Data Sheet-A.
- 5.1.9 The NGR shall be provided with suitable taps for cable/strip connection as specified in Section-I.
- 5.1.10 In case the connection between neutral terminal of transformer and NGR is through a copper strip, then copper strip shall be supplied by bidder. The required hardware for the termination of copper flat at both ends shall be supplied by the bidder.
- 5.2 ENCLOSURE:**
- 5.2.1 Each neutral grounding resistor shall be housed in weather-proof enclosure having Degree of Protection as specified in Data Sheet-A. Enclosure shall be cold rolled sheet steel having a minimum thickness of 2 mm. Suitable ventilating louvers shall be provided on sides to ensure proper ventilation. The louvers shall be provided with fine wire mesh to make vermin proof.
- 5.2.2 The terminals for neutral and earthing connections shall be housed in separate vermin-proof, weather-proof terminal box with min. IP-55 degree of ingress protection.
- 5.2.3 A separate canopy shall be provided above enclosure roof with a suitable air gap between them. It shall also cover the terminal compartment. Suitable lifting arrangement shall be provided to lift the canopy.
- 5.2.4 The bottom of the enclosure shall be provided with a drain plug to remove water that may get collected in the enclosure.



## TECHNICAL SPECIFICATION FOR NEUTRAL GROUNDING RESISTOR

SPECIFICATION NO. PE-SS- 999-506-E001

VOLUME II

SECTION - II

REVISION 01

DATE: 19.02.2019

SHEET 3 OF 5

- 5.2.5 The enclosure shall be supported on insulators placed on mounting structure in such a fashion that it is not easily accessible for man standing on ground level. Any part of insulator shall be at a height 2500 mm above ground/plinth.
- 5.2.6 Each cubicle shall be complete with front access door with handles, lock and also a removable bolted cover. All doors and removable covers shall be properly gasketed with good quality neoprene /synthetic rubber gaskets.
- 5.2.7 All cubicle door hinges shall be concealed type. Each cubicle shall be complete with suitably mounted cable box fitted with removable gland plate of Aluminium of suitable thickness for fixing cable gland. Double compression brass Cable glands and cable lugs of tinned copper shall be in the scope of bidder.
- 5.2.8 All necessary galvanised bolts, nuts washers etc. shall be included by the BIDDER for installation of Cubicle at site.
- 5.2.9 The enclosure shall not be earthed to prevent bypassing of resistor in case of any inadvertent shorting of resistor from inside.
- 5.2.10 Panel space heater arrangement along with thermostat, suitable for connection to 240V AC single supply, shall be provided at the bottom of the panel. The illumination arrangement and switch socket shall also be provided in the panel. The required cable glands, lug etc. required shall be supplied by the bidder.
- 5.2.11 For connection of other end of NGR to ground, Tinned copper flat (of size 50mm x 6mm) with Fork connector up to 300mm above ground with 2 nos. earthing terminal/pad, tapped holes and bolts suitable for Connection of GS Flat shall be provided by Bidder. The tinned copper flat shall be insulated from mounting structure through porcelain insulators. GS flat (size to be informed during detail engineering) for connection of fork connector of NGR to ground shall be in BHEL scope.

## 6.0 INSPECTION & TESTS

- 6.1 All tests shall be conducted as per relevant IS/IEC/ IEEE standards and shall be performed in the presence of purchaser's representative, if so desired by the purchaser. The bidder shall give at least 21 days advance notice of the date when the tests are to be carried out.
- 6.2 Bidder shall furnish Type Test certificates (temperature rise and DOP tests) conducted on similar type of equipment for purchaser's review at contract stage.
- 6.3 For all components / materials, for which type test reports have been asked for in the specification, such Type tests should have been carried out on identical components / materials. In absence of such type tests reports or in case such reports are not found to be meeting the specification/standards requirements, vendor shall conduct all such type tests without any commercial/delivery implication to BHEL according to the relevant standards and reports shall be submitted to the owner for approval. (Type test charges as per clause 6.4 shall not be applicable in such cases).
- 6.4 The bidder shall indicate cost of carrying out all the Type tests as specified in the specification. The charges for each of the Type tests shall be given separately as BOQ-cum-price schedule as part of NIT. These prices will be applicable in case a type test is required to be conducted by purchaser despite availability of satisfactory type test report as per clause 6.3 above.
- 6.5 All materials & components and shall be procured, manufactured, inspected, and tested by vendor/sub-vendor as per applicable clauses of BHEL Quality Plan no. PE-QP-999-505-E001, (subject to approval of customer) enclosed.



## TECHNICAL SPECIFICATION FOR NEUTRAL GROUNDING RESISTOR

SPECIFICATION NO. PE-SS- 999-506-E001

VOLUME II

SECTION - II

REVISION 01

DATE: 19.02.2019

SHEET 4 OF 5

- 6.6 All acceptance and routine tests as per relevant standards shall be carried out by the manufacturer. Charges for all these routine and acceptance tests for all the materials shall be deemed to be included in the bid price.
- 6.7 Test reports of the various tests conducted at the time of inspection shall be furnished by the vendor.
- 6.8 Bidder shall furnish unit prices of all items in the prescribed schedule of BOQ-cum-price schedule as part of NIT. Purchaser reserves the right to add/delete the quantity during detailed engineering as finally required for the project. Unit rate quoted shall be applicable for price adjustment in such cases.
- 6.9 All bought out items shall be procured from reputed manufacturers and shall be subject to approval of purchaser.

### 7.0 PAINTING

- 7.1 All bidders must have 7-tank or 8-tank painting procedure.
- 7.2 All metal parts, surfaces shall be degreased by dipping in hot alkaline solution and rubbed with wire brush to remove oil and scale and then rinsed in water. Alternatively, they may be shot blasted.
- 7.3 Parts shall be pickled by dipping in hydrochloric acid to remove the rust from the surfaces formed during storage of sheets and then rinsed to remove traces of the acid. The cleaning and pre-treatment of all metal parts shall be as per applicable standard.
- 7.4 The surfaces to be painted shall then be prepared by phosphatizing to protect them from further rusting and to create a good bond with the paint.
- 7.5 All parts shall then be subjected to a coat of primer paint. All inside surfaces of enclosure shall be spray painted with black matt finish and outside surfaces of enclosure shall be spray painted with hard semi glossy synthetic enamel or power coated (as specified in Sec-I) of shade as per Sec-I.
- 7.6 Paint thickness shall be minimum 50 microns unless specified otherwise in Sec-I.
- 7.7 Electrostatic or powder painting shall be acceptable subject to purchaser's approval.
- 7.8 Finished parts shall be coated with peelable compound by spraying method to protect the finished product from scratches, grease, dirty and oily spots during handling and transportation.

### 8.0 PACKING

- 8.1 Specification for the sea worthy packing, if enclosed, for the export jobs shall form part of the specification.

### 9.0 SPARES



## TECHNICAL SPECIFICATION FOR NEUTRAL GROUNDING RESISTOR

SPECIFICATION NO. PE-SS- 999-506-E001

VOLUME II

SECTION - II

REVISION 01

DATE: 19.02.2019

SHEET 5 OF 5

- 9.1 A list of Erection & commissioning spares (if required by BHEL) along with quantities considered is indicated in **BOQ-cum-price schedule as part of NIT**.
- 9.2 A list of Mandatory spares (if required by BHEL) along with quantities considered is indicated in **BOQ-cum-price schedule as part of NIT**.

### 10.0 GUARANTEED PERFORMANCE REQUIREMENTS

- 10.1 The vendor shall guarantee satisfactory performance of the equipment supplied under all conditions and requirement as laid down by this specification.
- 10.2 The vendor shall comply with the general requirements of performance guarantee specified elsewhere.

### 11.0 O & M MANUAL

O & M manual for installation, operation and maintenance of NGR shall be furnished before despatch of the equipment.

Draft O & M manual shall be submitted for purchaser's approval. Manual shall contain minimum following details:

- i) Description of the equipment.
- ii) Salient construction features.
- iii) Packing details.
- iv) Instructions to be followed on receipt at site for storage.
- v) Erection procedure & checks.
- vi) Test to be conducted at site.
- vii) Commissioning procedure.
- viii) Maintenance instructions.

### 13.0 DELIVERY

The delivery shall be as per NIT (Notice Inviting Tender).

|                                                                                  |                                                          |                                         |  |                                            |  |                         |  |
|----------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------|--|--------------------------------------------|--|-------------------------|--|
|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>STANDARD QUALITY PLAN</b>            |  | <b>SPEC. NO :</b>                          |  | <b>DATE:</b>            |  |
|                                                                                  |                                                          | <b>CUSTOMER :</b>                       |  | <b>QP NO.: PE-QP-999-506-E001, REV. 02</b> |  | <b>DATE: 30.03.2020</b> |  |
|                                                                                  |                                                          | <b>PROJECT:</b>                         |  | <b>PO NO.:</b>                             |  | <b>DATE:</b>            |  |
|                                                                                  |                                                          | <b>ITEM: NEUTRAL GROUNDING RESISTOR</b> |  | <b>SYSTEM: NGR</b>                         |  | <b>SECTION: II</b>      |  |

| S. NO. | COMPONENT & OPERATIONS | CHARACTERISTICS | CLASS | TYPE OF CHECK | QUANTUM OF CHECK |      | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | AGENCY |    |   | REMARKS |
|--------|------------------------|-----------------|-------|---------------|------------------|------|--------------------|------------------|------------------|--------|----|---|---------|
| 1      | 2                      | 3               | 4     | 5             | 6                |      | 7                  | 8                | 9                | *      | ** |   |         |
|        |                        |                 |       |               | M                | C/ N |                    |                  |                  | D      | M  | C | N       |

#### 1.0 RAW MATERIAL

|     |                            |                                        |    |                   |                |                                  |                                   |                                       |            |   |       |   |   |                                                                                                                    |
|-----|----------------------------|----------------------------------------|----|-------------------|----------------|----------------------------------|-----------------------------------|---------------------------------------|------------|---|-------|---|---|--------------------------------------------------------------------------------------------------------------------|
| 1.1 | SHEET STEEL AND STRUCTURES | 1. DIMENSIONS (THICKNESS)              | MA | MEASUREMENT       | 100%           | 10%                              | APPD. DATA SHEET, IS-1079, IS-513 | APPD. DATA SHEET, IS-1079, IS-513     | QC RECORD  | √ | P     | V | – | V - TO BE VERIFIED DURING FINAL INSPECTION                                                                         |
|     |                            | 2. SURFACE FINISH & WAVINESS/ FLATNESS | MI | VISUAL            | 100%           | 100%                             | IS-2062/ IS:1079/IS-513           | NO VISUAL DEFECTS/ CORROSION/ PITTING | -DO-       | √ | P     | V | – |                                                                                                                    |
|     |                            | 3. DUCTILITY OF SHEET                  | CR | BEND TEST         | SAMPLES        | SAMPLES                          | -DO-                              | IS-2062/ IS-513                       | TEST CERT. | √ | P / V | V | – | TEST CERT. FOR PLATING QUALITY TO BE PROVIDED                                                                      |
| 1.2 | COPPER FLATS               | 1. DIMENSIONS (THICKNESS)              | MA | MEASUREMENT       | 10%            | 10%                              | APPD. DATA SHEET                  | APPD. DATA SHEET                      | QC RECORD  | √ | P     | V | – | V - TO BE VERIFIED DURING FINAL INSPECTION                                                                         |
|     |                            | 2. SURFACE FINISH                      | MI | VISUAL            | 100%           | 100%                             | IS-1897                           | NO VISUAL DEFECTS/ CORROSION/ PITTING | -DO-       | √ | P     | V | – |                                                                                                                    |
|     |                            | 3. CHEMICAL COMPOSITION                | MA | CHEMICAL ANALYSIS | 1/ SAMPLE/ LOT | 1/ SAMPLE/ LOT                   | IS:440                            | IS:440                                | TEST CERT. | √ | P / V | V | – |                                                                                                                    |
| 1.3 | RESISTOR GRIDS             | 1. SURFACE FINISH                      | CR | VISUAL            | 100%           | 100%                             | APPD. DRG. / APPD. DATA SHEET     | APPD. DRG. / APPD. DATA SHEET         | QC RECORD  | √ | P     | V | – |                                                                                                                    |
|     |                            | 2. DIMENSIONS (THICKNESS & AREA)       | MA | MEASUREMENT       | 100%           | 1/ SAMPLE/ RESISTOR GRID ELEMENT | -DO-                              | -DO-                                  | -DO-       | √ | P     | W | – | W - ONE SAMPLE OF RESISTOR GRID ELEMENT SHOULD BE PROVIDED TO VERIFY THE DIMENSION AT THE TIME OF FINAL INSPECTION |

| BHEL         |             |                              |              |             |                      | BIDDER/ SUPPLIER |  | FOR CUSTOMER REVIEW & APPROVAL |             |      |      |
|--------------|-------------|------------------------------|--------------|-------------|----------------------|------------------|--|--------------------------------|-------------|------|------|
| ENGINEERING  |             |                              | QUALITY      |             |                      | Sign & Date      |  | Doc No:                        |             |      |      |
|              | Sign & Date | Name                         |              | Sign & Date | Name                 | Seal             |  |                                | Sign & Date | Name | Seal |
| Prepared by: |             | MEGHA/ NARENDRA NATH JAJWARE | Checked by:  |             | KUNDAN PRASAD        |                  |  | Reviewed by:                   |             |      |      |
| Reviewed by: |             | SANDEEP LODH                 | Reviewed by: |             | RITESH KUMAR JAISWAL |                  |  | Approved by:                   |             |      |      |

|                                                                                  |                                                          |                                         |  |                                            |  |                         |  |
|----------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------|--|--------------------------------------------|--|-------------------------|--|
|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>STANDARD QUALITY PLAN</b>            |  | <b>SPEC. NO :</b>                          |  | <b>DATE:</b>            |  |
|                                                                                  |                                                          | <b>CUSTOMER :</b>                       |  | <b>QP NO.: PE-QP-999-506-E001, REV. 02</b> |  | <b>DATE: 30.03.2020</b> |  |
|                                                                                  |                                                          | <b>PROJECT:</b>                         |  | <b>PO NO.:</b>                             |  | <b>DATE:</b>            |  |
|                                                                                  |                                                          | <b>ITEM: NEUTRAL GROUNDING RESISTOR</b> |  | <b>SYSTEM: NGR</b>                         |  | <b>SECTION: II</b>      |  |

| S. NO. | COMPONENT & OPERATIONS                              | CHARACTERISTICS             | CLASS | TYPE OF CHECK | QUANTUM OF CHECK |        | REFERENCE DOCUMENT            | ACCEPTANCE NORMS              | FORMAT OF RECORD | AGENCY |       |   |   | REMARKS |
|--------|-----------------------------------------------------|-----------------------------|-------|---------------|------------------|--------|-------------------------------|-------------------------------|------------------|--------|-------|---|---|---------|
| 1      | 2                                                   | 3                           | 4     | 5             | 6                |        | 7                             | 8                             | 9                | *      | **    |   |   |         |
|        |                                                     |                             |       |               | M                | C/ N   |                               |                               |                  | D      | M     | C | N |         |
|        |                                                     | 3. RESISTANCE VALUE         | MA    | ELECTRICAL    | 100%             | 100%   | -DO-                          | -DO-                          | -DO-             | √      | P     | V | — |         |
|        |                                                     | 4. CHEMICAL COMPOSITION     | MA    | CHEM ANALYSIS | 1/ LOT           | 1/ LOT | MFR'S. STD.                   | MFR'S. STD.                   | TEST CERT.       | √      | P / V | V | — |         |
| 1.4    | MICA INSULATED TIE-RODS, MICA WASHERS, STEEL WASHER | 1. DIMENSIONS               | MA    | MEASUREMENT   | 100%             | 100%   | MFR'S. STD.                   | MFR'S. STD.                   | QC RECORD        | √      | P     | V | — |         |
|        |                                                     | 2. SURFACE                  | MA    | VISUAL        | 100%             | 100%   | -DO-                          | -DO-                          | -DO-             | √      | P     | V | — |         |
| 1.5    | PORCELAIN INSULATORS (POST & BUSHING TYPES)         | 1. DIMENSIONS CHECK         | MA    | MEASUREMENT   | 100%             | 100%   | IS-3347                       | IS-3347                       | TEST CERT.       | √      | P     | V | — |         |
|        |                                                     | 2. SURFACE FINISH & DEFECTS | MA    | MEASUREMENT   | 100%             | 100%   | MFR'S. STD.                   | MFR'S. STD.                   | -DO-             | √      | P     | V | — |         |
|        |                                                     | 3. DRY P.F. HV TEST         | MA    | ELEC.         | 100%             | 100%   | APPD. DRG. / APPD. DATA SHEET | APPD. DRG. / APPD. DATA SHEET | -DO-             | √      | P     | V | — |         |

## 2.0 FABRICATION

|     |                                                    |                              |    |             |      |      |                               |                               |           |   |   |   |   |  |
|-----|----------------------------------------------------|------------------------------|----|-------------|------|------|-------------------------------|-------------------------------|-----------|---|---|---|---|--|
| 2.1 | CUTTING, BENDING, PUNCHING, DRILLING & WELDING ETC | 1. DIMENSIONS                | MA | MEASUREMENT | 100% | 100% | MFG. STAND.                   | MFG. STAND.                   | QC RECORD | √ | P | V | — |  |
|     |                                                    | 2. WORK MANSHIP              | MA | VISUAL      | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
| 2.2 | SURFACE PREPARATION                                | 1. SURFACE CONDITION         | MA | VISUAL      | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
| 2.3 | PAINTING                                           | 1. SURFACE FINISH & COVERAGE | MA | VISUAL      | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
|     |                                                    | 2. FILM THICKNESS            | MA | MEASUREMENT | 100% | 100% | APPD. DRG. / APPD. DATA SHEET | APPD. DRG. / APPD. DATA SHEET | -DO-      | √ | P | V | — |  |
|     |                                                    | 3. PAINT SHADE               | MA | VISUAL      | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |

|                    |             |                              |                |             |                      |                         |  |                                           |             |      |      |
|--------------------|-------------|------------------------------|----------------|-------------|----------------------|-------------------------|--|-------------------------------------------|-------------|------|------|
| <b>BHEL</b>        |             |                              |                |             |                      | <b>BIDDER/ SUPPLIER</b> |  | <b>FOR CUSTOMER REVIEW &amp; APPROVAL</b> |             |      |      |
| <b>ENGINEERING</b> |             |                              | <b>QUALITY</b> |             |                      | Sign & Date             |  | Doc No:                                   |             |      |      |
|                    | Sign & Date | Name                         |                | Sign & Date | Name                 | Seal                    |  |                                           | Sign & Date | Name | Seal |
| Prepared by:       |             | MEGHA/ NARENDRA NATH JAJWARE | Checked by:    |             | KUNDAN PRASAD        |                         |  | Reviewed by:                              |             |      |      |
| Reviewed by:       |             | SANDEEP LODH                 | Reviewed by:   |             | RITESH KUMAR JAISWAL |                         |  | Approved by:                              |             |      |      |

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|----------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------|--|--------------------------------------------|--|-------------------------|--|
|  | <b>MANUFACTURER/ BIDDER/ SUPPLIER NAME &amp; ADDRESS</b> | <b>STANDARD QUALITY PLAN</b>            |  | <b>SPEC. NO :</b>                          |  | <b>DATE:</b>            |  |
|                                                                                  |                                                          | <b>CUSTOMER :</b>                       |  | <b>QP NO.: PE-QP-999-506-E001, REV. 02</b> |  | <b>DATE: 30.03.2020</b> |  |
|                                                                                  |                                                          | <b>PROJECT:</b>                         |  | <b>PO NO.:</b>                             |  | <b>DATE:</b>            |  |
|                                                                                  |                                                          | <b>ITEM: NEUTRAL GROUNDING RESISTOR</b> |  | <b>SYSTEM: NGR</b>                         |  | <b>SECTION: II</b>      |  |

| S. NO. | COMPONENT & OPERATIONS | CHARACTERISTICS | CLASS | TYPE OF CHECK | QUANTUM OF CHECK |      | REFERENCE DOCUMENT | ACCEPTANCE NORMS | FORMAT OF RECORD | AGENCY |    |   |   | REMARKS |
|--------|------------------------|-----------------|-------|---------------|------------------|------|--------------------|------------------|------------------|--------|----|---|---|---------|
| 1      | 2                      | 3               | 4     | 5             | 6                |      | 7                  | 8                | 9                | *      | ** |   |   |         |
|        |                        |                 |       |               | M                | C/ N |                    |                  |                  | D      | M  | C | N |         |

### 3.0 SUB-ASSEMBLY

|     |                                                                    |                     |    |             |      |      |                               |                               |           |   |   |   |   |  |
|-----|--------------------------------------------------------------------|---------------------|----|-------------|------|------|-------------------------------|-------------------------------|-----------|---|---|---|---|--|
| 3.1 | RESISTOR UNIT FRAME ASSEMBLED                                      | 1. HV TEST          | CR | ELECTRICAL  | 100% | 100% | DATA SHEET,                   | DATA SHEET,                   | QC RECORD | √ | P | V | — |  |
|     |                                                                    | 2.RESISTANCE VALUE  | CR | ELECTRICAL  | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
|     |                                                                    | 3. DIMENSIONS       | MA | MEASUREMENT | 100% | 100% | MFG. STAND.                   | MFG. STAND.                   | -DO-      | √ | P | V | — |  |
| 3.2 | FITTING OF RESISTOR UNIT FRAME, PORCELAIN BUSHING & POST INSULATOR | 1. FITMENT          | MA | VISUAL      | 100% | 100% | APPD. DRG. / APPD. DATA SHEET | APPD. DRG. / APPD. DATA SHEET | QC RECORD | √ | P | V | — |  |
|     |                                                                    | 2. DIMENSION        | MA | MEASUREMENT | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
|     |                                                                    | 3. CONNECTION       | MA | VISUAL      | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
|     |                                                                    | 4. TERMINATION      | MA | MEASUREMENT | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
|     |                                                                    | 5. RESISTANCE VALUE | MA | ELECTRICAL  | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
| 3.3 | ENCLOSURE & ITS PARTS                                              | 1. FINISH           | MA | VISUAL      | 100% | 100% | APPD. DRG. / APPD. DATA SHEET | APPD. DRG. / APPD. DATA SHEET | QC RECORD | √ | P | V | — |  |
|     |                                                                    | 2. DIMENSION        | MA | MEASUREMENT | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |
|     |                                                                    | 3. PAINT SHADE      | MA | VISUAL      | 100% | 100% | -DO-                          | -DO-                          | -DO-      | √ | P | V | — |  |

### 4.0 FINAL ASSEMBLY

|     |              |                                                        |    |            |      |      |                                             |                                             |             |   |   |   |   |                                      |
|-----|--------------|--------------------------------------------------------|----|------------|------|------|---------------------------------------------|---------------------------------------------|-------------|---|---|---|---|--------------------------------------|
| 3.1 | COMPLETE NGR | 1. HV TEST                                             |    |            |      |      |                                             |                                             |             |   |   |   |   |                                      |
|     |              | (a) BETWEEN NEUTRAL BUS AND ENCLOSURE                  | CR | ELECTRICAL | 100% | 100% | APPD. DRG. / APPD. DATA SHEET, STD. IEEE 32 | APPD. DRG. / APPD. DATA SHEET, STD. IEEE 32 | TEST REPORT | √ | P | W | — |                                      |
|     |              | (b) BETWEEN RESISTOR ELEMENT AND END SUPPORT STRUCTURE | CR | ELECTRICAL | 100% | 100% | STD. IEEE 32 clause 10.3.2                  | STD. IEEE 32 clause 10.3.2                  | -DO-        | √ | P | W | — |                                      |
|     |              | 2. MEASUREMENT OF IR VALUE BEFORE & AFTER HV TEST      | CR | ELECTRICAL | 100% | 100% | APPD. DRG. / APPD. DATA SHEET, STD. IEEE 32 | APPD. DRG. / APPD. DATA SHEET, STD. IEEE 32 | -DO-        | √ | P | W | — | SHALL BE DONE BEFORE & AFTER HV TEST |

|                    |             |                              |                |             |                      |                         |  |                                           |             |      |      |
|--------------------|-------------|------------------------------|----------------|-------------|----------------------|-------------------------|--|-------------------------------------------|-------------|------|------|
| <b>BHEL</b>        |             |                              |                |             |                      | <b>BIDDER/ SUPPLIER</b> |  | <b>FOR CUSTOMER REVIEW &amp; APPROVAL</b> |             |      |      |
| <b>ENGINEERING</b> |             |                              | <b>QUALITY</b> |             |                      | Sign & Date             |  | Doc No:                                   |             |      |      |
|                    | Sign & Date | Name                         |                | Sign & Date | Name                 | Seal                    |  |                                           | Sign & Date | Name | Seal |
| Prepared by:       |             | MEGHA/ NARENDRA NATH JAJWARE | Checked by:    |             | KUNDAN PRASAD        |                         |  | Reviewed by:                              |             |      |      |
| Reviewed by:       |             | SANDEEP LODH                 | Reviewed by:   |             | RITESH KUMAR JAISWAL |                         |  | Approved by:                              |             |      |      |

|                                                                                  |                                                              |                                         |                    |                                            |                          |
|----------------------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------|--------------------|--------------------------------------------|--------------------------|
|  | <b>MANUFACTURER/ BIDDER/<br/>SUPPLIER NAME &amp; ADDRESS</b> | <b>STANDARD QUALITY PLAN</b>            |                    | <b>SPEC. NO :</b>                          | <b>DATE:</b>             |
|                                                                                  |                                                              | <b>CUSTOMER :</b>                       |                    | <b>QP NO.: PE-QP-999-506-E001, REV. 02</b> | <b>DATE: 30.03.2020</b>  |
|                                                                                  |                                                              | <b>PROJECT:</b>                         |                    | <b>PO NO.:</b>                             | <b>DATE:</b>             |
|                                                                                  |                                                              | <b>ITEM: NEUTRAL GROUNDING RESISTOR</b> | <b>SYSTEM: NGR</b> | <b>SECTION: II</b>                         | <b>SHEET Page 4 of 6</b> |

| S. NO. | COMPONENT & OPERATIONS | CHARACTERISTICS                              | CLASS | TYPE OF CHECK | QUANTUM OF CHECK           |                            | REFERENCE DOCUMENT                                   | ACCEPTANCE NORMS                                     | FORMAT OF RECORD | AGENCY |    |       |   | REMARKS                                                                                                                                                                                                                                                                                                                         |
|--------|------------------------|----------------------------------------------|-------|---------------|----------------------------|----------------------------|------------------------------------------------------|------------------------------------------------------|------------------|--------|----|-------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | 2                      | 3                                            | 4     | 5             | 6                          |                            | 7                                                    | 8                                                    | 9                | *      | ** |       |   |                                                                                                                                                                                                                                                                                                                                 |
|        |                        |                                              |       |               | M                          | C/ N                       |                                                      |                                                      |                  | D      | M  | C     | N |                                                                                                                                                                                                                                                                                                                                 |
|        |                        | 3. RESISTANCE VALUE                          | CR    | ELECTRICAL    | 100%                       | 100%                       | -DO-                                                 | -DO-                                                 | -DO-             | √      | P  | W     | — |                                                                                                                                                                                                                                                                                                                                 |
|        |                        | 4. DIMENSIONS                                | MA    | MEASUREMENT   | 100%                       | 100%                       | -DO-                                                 | -DO-                                                 | -DO-             | √      | P  | W     | — |                                                                                                                                                                                                                                                                                                                                 |
|        |                        | 5. SHORT TIME RATING / TEMPERATURE RISE TEST | MA    | HEAT RUN      | 1/TYP E/<br>VOL.<br>GRAD E | 1/TYP E/<br>VOL.<br>GRAD E | APPD. DRG. / APPD. DATA SHEET                        | APPD. DRG. / APPD. DATA SHEET                        | TYPE TEST REPORT | √      | P  | V / W | — | V TYPE TEST CERTIFICATE OF SIMILAR RATING TO BE FURNISHED FOR VERIFICATION BY ENGINEERING. VALIDITY OF TYPE TEST REPORT IS 5 YEARS FROM DATE OF ISSUE OF REPORT<br><br>W CONDUCTION OF TYPE TEST TO BE DONE IF CALLED FOR IN TECHNICAL SPECIFICATION & TEST REPORT OF THE SAME TO BE FURNISHED FOR VERIFICATION BY ENGINEERING. |
|        |                        | 6. DEGREE OF PROTECTION                      | MA    | MEASUREMENT   | 1/TYP E/<br>VOL.<br>GRAD E | 1/TYP E/<br>VOL.<br>GRAD E | APPD. DRG. / APPD. DATA SHEET/ IEC:60529/ EQVT. STD. | APPD. DRG. / APPD. DATA SHEET/ IEC:60529/ EQVT. STD. | TYPE TEST REPORT | √      | P  | V     | — | V TYPE TEST CERTIFICATE OF SIMILAR RATING TO BE FURNISHED FOR VERIFICATION BY ENGINEERING. VALIDITY OF TYPE TEST REPORT IS 5 YEARS FROM DATE OF ISSUE OF REPORT.                                                                                                                                                                |
|        |                        | 7. PAINT FINISH                              | MA    | VISUAL        | 100%                       | 100%                       | APPD. DRG. / APPD. DATA SHEET                        | APPD. DRG. / APPD. DATA SHEET                        | TEST REPORT      | √      | P  | W     | — |                                                                                                                                                                                                                                                                                                                                 |
|        |                        | 8. PAINT THICKNESS                           | MA    | MEASUREMENT   | 100%                       | 100%                       | -DO-                                                 | -DO-                                                 | TEST             | √      | P  | W     | — |                                                                                                                                                                                                                                                                                                                                 |

|                    |             |                              |                |             |                      |                         |  |                                           |             |      |      |
|--------------------|-------------|------------------------------|----------------|-------------|----------------------|-------------------------|--|-------------------------------------------|-------------|------|------|
| <b>BHEL</b>        |             |                              |                |             |                      | <b>BIDDER/ SUPPLIER</b> |  | <b>FOR CUSTOMER REVIEW &amp; APPROVAL</b> |             |      |      |
| <b>ENGINEERING</b> |             |                              | <b>QUALITY</b> |             |                      | Sign & Date             |  | Doc No:                                   |             |      |      |
|                    | Sign & Date | Name                         |                | Sign & Date | Name                 | Seal                    |  |                                           | Sign & Date | Name | Seal |
| Prepared by:       |             | MEGHA/ NARENDRA NATH JAJWARE | Checked by:    |             | KUNDAN PRASAD        |                         |  | Reviewed by:                              |             |      |      |
| Reviewed by:       |             | SANDEEP LODH                 | Reviewed by:   |             | RITESH KUMAR JAISWAL |                         |  | Approved by:                              |             |      |      |

|                                                                                  |                                                              |                                         |  |                                            |  |                         |  |
|----------------------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------|--|--------------------------------------------|--|-------------------------|--|
|  | <b>MANUFACTURER/ BIDDER/<br/>SUPPLIER NAME &amp; ADDRESS</b> | <b>STANDARD QUALITY PLAN</b>            |  | <b>SPEC. NO :</b>                          |  | <b>DATE:</b>            |  |
|                                                                                  |                                                              | <b>CUSTOMER :</b>                       |  | <b>QP NO.: PE-QP-999-506-E001, REV. 02</b> |  | <b>DATE: 30.03.2020</b> |  |
|                                                                                  |                                                              | <b>PROJECT:</b>                         |  | <b>PO NO.:</b>                             |  | <b>DATE:</b>            |  |
|                                                                                  |                                                              | <b>ITEM: NEUTRAL GROUNDING RESISTOR</b> |  | <b>SYSTEM: NGR</b>                         |  | <b>SECTION: II</b>      |  |

|        |                        |                                                                      |       |                      |                       |                       |                               |                               | REPORT                  |        |    |   |   |            |
|--------|------------------------|----------------------------------------------------------------------|-------|----------------------|-----------------------|-----------------------|-------------------------------|-------------------------------|-------------------------|--------|----|---|---|------------|
|        |                        | 9. PAINT SHADE                                                       | MI    | VISUAL-SHADE CARD    | 100%                  | 100%                  | -DO-                          | -DO-                          | TEST REPORT             | √      | P  | W | - |            |
| S. NO. | COMPONENT & OPERATIONS | CHARACTERISTICS                                                      | CLASS | TYPE OF CHECK        | QUANTUM OF CHECK      |                       | REFERENCE DOCUMENT            | ACCEPTANCE NORMS              | FORMAT OF RECORD        | AGENCY |    |   |   | REMARKS    |
| 1      | 2                      | 3                                                                    | 4     | 5                    | 6                     |                       | 7                             | 8                             | 9                       | *      | ** |   |   |            |
|        |                        |                                                                      |       |                      | M                     | C/ N                  |                               |                               |                         | D      | M  | C | N |            |
|        |                        | 10. PAINT ADHESION TEST                                              | MI    | MECHANICAL           | FEW PLACES OF ALL NGR | FEW PLACES OF ALL NGR | -DO-                          | -DO-                          | -DO-                    | √      | P  | W | - |            |
|        |                        | 11. THICKNESS OF GALVANISINGS OF STRUCTURE                           | MI    | VISUAL / MEASUREMENT | 100%                  | 100%                  | APPD. DRG. / APPD. DATA SHEET | APPD. DRG. / APPD. DATA SHEET | -DO-                    | √      | P  | W | - |            |
|        |                        | 12. CHECKING OF EARTH CONNECTION                                     | MA    | ELECTRICAL           | 100%                  | 100%                  | -DO-                          | -DO-                          | -DO-                    | √      | P  | W | - |            |
|        |                        | 13. CHECKING OF EARTHING MATERIAL (TINNED COPPER STRIP)              | MA    | VISUAL               | 100%                  | 100%                  | -DO-                          | -DO-                          | -DO-                    | √      | P  | W | - |            |
|        |                        | 14. VERIFICATION OF BOM INCLUDING CABLE GLAND & LUGS (AS APPLICABLE) | MA    | VISUAL               | 100%                  | 100%                  | -DO-                          | -DO-                          | -DO-                    | √      | P  | W | - |            |
|        |                        | 15. PACKING                                                          | MA    | VISUAL               | 100%                  | 100%                  | AS PER SPECIFICATION          | AS PER SPECIFICATION          | SOFT COPY OF PHOTOGRAPH | √      | P  | W | - | REFER NOTE |

| BHEL         |             |                              |              |             |                      | BIDDER/ SUPPLIER |  | FOR CUSTOMER REVIEW & APPROVAL |             |      |      |
|--------------|-------------|------------------------------|--------------|-------------|----------------------|------------------|--|--------------------------------|-------------|------|------|
| ENGINEERING  |             |                              | QUALITY      |             |                      | Sign & Date      |  | Doc No:                        |             |      |      |
|              | Sign & Date | Name                         |              | Sign & Date | Name                 |                  |  |                                | Sign & Date | Name | Seal |
| Prepared by: |             | MEGHA/ NARENDRA NATH JAJWARE | Checked by:  |             | KUNDAN PRASAD        |                  |  | Reviewed by:                   |             |      |      |
| Reviewed by: |             | SANDEEP LODH                 | Reviewed by: |             | RITESH KUMAR JAISWAL |                  |  | Approved by:                   |             |      |      |

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|----------------------------------------------------------------------------------|--------------------------------------------------------------|---------------------------------------------|--------------------|--------------------------------------------|--------------------------|
|  | <b>MANUFACTURER/ BIDDER/<br/>SUPPLIER NAME &amp; ADDRESS</b> | <b>STANDARD QUALITY PLAN</b>                |                    | <b>SPEC. NO :</b>                          | <b>DATE:</b>             |
|                                                                                  |                                                              | <b>CUSTOMER :</b>                           |                    | <b>QP NO.: PE-QP-999-506-E001, REV. 02</b> | <b>DATE: 30.03.2020</b>  |
|                                                                                  |                                                              | <b>PROJECT:</b>                             |                    | <b>PO NO.:</b>                             | <b>DATE:</b>             |
|                                                                                  |                                                              | <b>ITEM: NEUTRAL GROUNDING<br/>RESISTOR</b> | <b>SYSTEM: NGR</b> | <b>SECTION: II</b>                         | <b>SHEET Page 6 of 6</b> |

**NOTES:**

1. BHEL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST IF REQUIRED.
2. IN CASE OF FOREIGN SUPPLIER, ALL TEST CERTIFICATES SHALL BE FURNISHED BY THE SUPPLIER, DULY WITNESSED/ VERIFIED BY SUPPLIER'S TPI.
3. PHOTOGRAPHS OF COMPLETE NGR AFTER PACKING TO BE SENT TO BHEL PURCHASE GROUP FOR REVIEW BEFORE ISSUING MDCC.
4. IN CASE THERE ARE ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE, THE SAME SHALL BE CARRIED OUT BY THE BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
5. PROJECT SPECIFIC QUALITY PLAN TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
6. FOR EXPORT JOB, PACKING SHALL BE AS PER BHEL SEAWORTHY PACKING SPECIFICATION.
7. LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.
8. PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

**LEGENDS:**

\*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, **D:** DOCUMENTATION  
**\*\* M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **C:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **N:** CUSTOMER,  
**P:** PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE  
**MA:** MAJOR, **MI:** MINOR, **CR:** CRITICAL

| BHEL         |             |                                    |              |             |                         | BIDDER/ SUPPLIER |  | FOR CUSTOMER REVIEW & APPROVAL |             |      |      |
|--------------|-------------|------------------------------------|--------------|-------------|-------------------------|------------------|--|--------------------------------|-------------|------|------|
| ENGINEERING  |             |                                    | QUALITY      |             |                         | Sign & Date      |  | Doc No:                        |             |      |      |
|              | Sign & Date | Name                               |              | Sign & Date | Name                    | Seal             |  |                                | Sign & Date | Name | Seal |
| Prepared by: |             | MEGHA/<br>NARENDRA<br>NATH JAJWARE | Checked by:  |             | KUNDAN<br>PRASAD        |                  |  | Reviewed by:                   |             |      |      |
| Reviewed by: |             | SANDEEP LODH                       | Reviewed by: |             | RITESH KUMAR<br>JAISWAL |                  |  | Approved by:                   |             |      |      |